Prevalence of self-reported food allergy in U.S. adults: 2001, 2006, and 2010

Linda Verrill, Ph.D.,[1] Richard Bruns, Ph.D.,[2] and Stefano Luccioli, M.D.[3]

ABSTRACT

Background: *Epidemiologic evidence indicates that food allergies are increasing in the population. Information on a change in self-reported food allergy (srFA) in adults over time is lacking.*

Objective: *To report the prevalence of srFA and compare differences at three time points over a decade.*

Methods: *We analyzed srFA and reported physician-diagnosed food allergy in >4000 U.S. adults who participated in the 2010 U.S. Food and Drug Administration Food Safety Survey. Information on causative food(s), reaction severity characteristics, and various diagnostic factors was also analyzed. We compared 2010 Food Safety Survey data with 2006 and 2001 data, and highlighted relevant differences.*

Results: *SrFA prevalence increased significantly, to 13% in 2010 and 14.9% in 2006 compared with 9.1% in 2001 ($p < 0.001$). Physician diagnosed food allergy was 6.5% in 2010, which was not significantly different compared with 7.6% in 2006 and 5.3% in 2001. SrFA increased in both men and women, non-Hispanic white and black adults, 50–59 year olds, and in adults with a high school or lower education. In 2010, milk, shellfish, and fruits were the most commonly reported food allergens, similar to 2001. Also, in 2010, 15% of reactions reportedly required a hospital visit and 8.4% were treated with epinephrine. Minor differences in reaction severity characteristics were noted among the surveys.*

Conclusions: *Analysis of survey results indicates that the prevalence of srFA increased among U.S. adults from 2001 to 2010 and that adults are increasingly self-reporting FAs without obtaining medical diagnosis. Improved education about food allergies is needed for this risk group.*

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Food allergy (FA) is a recognized public health problem. FA reactions can be fatal and are a leading cause of anaphylactic events treated in hospital emergency departments.[1–3] Adding to this problem is reported evidence of an increasing trend in the prevalence of FA in children[4–6] and to certain foods, *e.g.*, peanut,[7,8] over a period of a decade. Despite these observations, a demonstration of how this trend is shaping in adults is lacking. Understanding trends in FA has important value in understanding the impact of clinical and public health mitigating strategies.

Over the past 2 decades, population-based studies aimed at estimating the true prevalence of general or specific FAs in North America have largely relied on self-reported national health survey data.[4,7,9–20] Most studies further validated some or all survey data with reports of convincing allergic symptom[7,9,10,15–18] and/or physician diagnosis information either by report alone[12,13,17,19] or confirmation by medical record or testing information.[9,10,18] Still other studies estimated prevalence based on International Classification of Diseases coded allergic events[4] or allergen-specific immunoglobulin E (IgE) information alone,[21] without confirmation of FA symptoms. Comprehensively, between 1997 and 2011, these studies estimated a North American population prevalence of reported allergy to all foods in 3.9–8% (infants and children) and 6.6–10% (adults), and to individual foods that ranged from 0 to 2.5% (versus 0 to 9% for any sensitization; peanut being the highest.[4,21]) The only available national trend information for adults has been for peanut and tree nut allergies, and this showed a relatively stable prevalence between 1997 and 2007.[7]

The primary objective of the current study was to analyze self-reported FA (srFA) prevalence data in adults from the two most recent U.S. Food and Drug Administration Food Safety Surveys (FSS) and to compare with 2001 FSS data,[19] to assess how the prevalence of srFA has changed over a decade in U.S. adults.

METHODS

The FSS is a cross-sectional, list-assisted, random-digit-dial landline telephone survey of American consumers conducted every 3–5 years since 1988. Respon-

From the [1]Center for Food Safety and Applied Nutrition, Division of Public Health, Informatics, and Analytics, Consumer Studies Branch, U.S. Food and Drug Administration, College Park, Maryland, [2]Office of the Commissioner, Office of Policy, Planning, Legislation, and Analysis, Office of Planning, Economics Staff, U.S. Food and Drug Administration, College Park, Maryland, and [3]Center for Food Safety and Applied Nutrition, Office of Food Additive Safety, U.S. Food and Drug Administration, College Park, Maryland

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Address correspondence to Linda Verrill, Ph.D., U.S. Food and Drug Administration, 5100 Paint Branch Parkway, College Park, MD 20740

E-mail address: linda.verrill@fda.hhs.gov

dents are 18 years of age or older.[22] The response rate for the 2001 survey was 35.8% versus 30% in 2006 and 14% in 2010. (Results of tests for nonresponse bias are available by request from the corresponding author [L.V.].) The total sample sizes of all the surveys were similar (4482 in 2001, 4539 in 2006, and 4568 in 2010). The surveys were administered in English and Spanish in the 48 contiguous U.S. states, and were reviewed by U.S. Food and Drug Administration's Research Involving Human Subjects Protection Committee.

A series of questions that addressed participants' experience with FA were categorized and added to the 2001, 2006, and 2010 surveys; most, but not all, questions were consistent among the surveys (Table 1). These questions were developed and cognitively tested for clarity, completeness, and relevance of item content with members of the Food Allergy and Anaphylaxis Network.[19] In all the surveys, adults were asked a variation of the question "do you currently have any food allergy or suspect that you have a food allergy?" Respondents who answered "yes" were defined as adult respondents with srFA. No definition for FA was provided to respondents. This self-identified FA group was further subdivided based on whether they reported yes to the question "was your allergy diagnosed by a doctor?"; hereafter referred to as physician-diagnosed FA (ddFA). Questions that related to reaction severity characteristics were mostly similar among the surveys. However, the methods for querying and recording the foods to which respondents were allergic differed. In 2001, respondents were asked to name up to six causative foods; whereas, in 2010, the interviewer read a list of foods and food categories, and asked the respondents to indicate if they were allergic to each one of them. Variables based on questions that differed significantly among surveys were not analyzed for trend differences.

We used SPSS version 21(SPSS Inc., Chicago, IL) for data analysis. The χ^2 test of independence was used to assess statistically significant differences, and, because of the number of statistical tests conducted, the Bonferroni adjustment was used to determine statistical significance.

The number of respondents mentioned in the text and contained in the tables is unweighted. Prevalence estimates for all survey years reported, are weighted based on distributions in the Current Population Survey for the current or previous year of data collection and are a combined value of sex (two categories), educational attainment (four categories), and race and/or ethnicity (four categories). Because of large changes in U.S. population age distribution, age (three categories) was calculated in the weights for the 2010 FSS.

RESULTS

In 2010, 574 adults (13%) self-reported having an srFA (Table 2) and 323 (6.5%) in 2010 self-reported a ddFA (Table 3). This was compared with 737 (14.9%) and 385 (7.6%) in 2006, and 471 (9.1%) and 279 (5.3%) in 2001 reporting srFA and ddFA, respectively. Based on these values, the prevalence of srFA was significantly increased ($p < 0.001$) in both 2006 and 2010 compared with 2001. The significant increase in srFA ($p < 0.001$) for both 2006 and 2010 survey years was consistently noted in both men and women, individuals ages 50–59 years, non-Hispanic whites and blacks, and individuals with a high school or less education. For ddFA, prevalence in 2006 was significantly increased from 2001 ($p < 0.001$) but was not significantly different from 2010. No significant difference in ddFA prevalence was noted between 2001 and 2010 surveys ($p = 0.092$). Although some significant subcategory increases in ddFA prevalence from 2001 to 2006 were noted for men, non-Hispanic blacks, and individuals with a high school or less education, there were no significant subcategory increases in ddFA prevalence between the 2001 and 2010 surveys. Thus, by using 2001 and 2010 time end points, analysis of our results indicates no significant change in ddFA prevalence over this decade.

Although not shown in Tables 2 or 3, some differences were noted within demographic groups for both srFA and ddFA in 2010. Female adults were significantly more likely than male adults to report a ddFA ($p < 0.001$). Hispanic adults were approximately half as likely as non-Hispanic white and non-Hispanic black individuals to report either ddFA or srFA ($p < 0.001$) There were no differences in the level of education for those with ddFA or srFA.

The prevalences of allergy to specific foods within srFA and ddFA groups of the most recent 2010 survey are shown in Table 4. Seventy-five percent of adults with srFA and 76% of those with ddFA reported reactions to at least one of the major food allergens (*i.e.*, milk and/or dairy, eggs, fish, shellfish, tree nuts, peanuts, wheat and/or gluten, soy) defined by Food Allergen Labeling and Consumer Protection Act.[23] In addition, the most frequently implicated foods as causes of allergic reactions within both the srFA and ddFA groups were similar. Foods associated with the highest prevalence of srFA were milk and/or dairy (4.1%), shellfish (3.6%), fruits (2.7%), fish (1.7%), and tree nuts and wheat and/or gluten (1.3% each), whereas foods associated with the highest prevalence of ddFA were milk and/or dairy (2.0%), shellfish (1.6%), fruits (1.6%), wheat and/or gluten (0.9%), fish (0.8%), tree nuts (0.7%), and peanut (0.6%). Although questions were asked differently in 2010 compared with 2001, the most frequently reported foods (milk,

Table 1 **Verbatim FA questions from the 2001, 2006, and 2010 U.S. Food and Drug Administration FSS**

	Survey Year Reported		
	2001	**2006**	**2010**
Allergy and diagnoses (Tables 2 and 3)			
Do you or does anyone who lives in your home with you currently have any food allergies, or does anyone suspect that he or she has a food allergy?	×		
Now, I'd like to ask if you have any current food allergies or do you suspect that you have a food allergy?		×	×
Has a medical doctor diagnosed your condition as a food allergy?	×	×	×
How did the doctor make the diagnosis? (open ended)	×		
How did the doctor make the diagnosis of a food allergy? (open ended)		×	×
Foods (Table 4)*			
What foods or food ingredients are you allergic to? I am going to read you a list. Please answer yes or no for each food category.			×
Are you allergic to any milk or dairy?			×
What about eggs?			×
Any type of fish or shellfish? (What type?)			×
What type of shellfish are you allergic to?			×
Are you allergic to any type of nuts or seeds? (What type?)			×
Are you allergic to wheat, gluten, corn, or other grains?			×
Are you allergic to any fruits or vegetables? (What type?)			×
Are you allergic to any kind of beans or legumes? (What type?)			×
Are you allergic to any other foods? (What type?)			×
Reactions (Table 5)#			
If you eat any of this food, which of these reactions do you have? Do you have . . .?	×		
What kinds of reactions have you had to the food(s) you are allergic to? Please respond with yes or no to each item I read.			×
Skin reaction, such as hives, itching, or redness	×		×
Swelling of face	×		×
Itchy lips or mouth	×		×
Throat tightness or itchy throat	×		×
Wheezing	×		×
Trouble breathing, shortness of breath, or coughing	×		×
Nasal congestion	×		×
Stomach pain	×		×
Vomiting or nausea	×		×
Diarrhea	×		×
Reaction severity (Table 6)#			
When was the last time you had an allergic reaction to food or had symptoms you thought were caused by an allergic reaction to food?	×		×
How many total food allergic reactions have you had in the past 5 years?	Not asked		×
Was epinephrine used to treat this most recent reaction?	×		×
Were you treated in a hospital or doctor's office for this reaction?	×		×
Thinking about the food that caused the reaction we were just talking about, was it: (1) A packaged food eaten without further preparation, such as milk or cookies; (2) a prepared food cooked or made at a home, a restaurant, or other such place; or (3) a food that did not come in a package and was not prepared, such as a piece of fruit?	×		×

FA = food allergy; FSS = U.S. Food and Drug Administration Food Safety Surveys.
**Results for 2001 were previously reported by Vierk et al.*[19]
#Comparisons were made only between 2001 and 2010.

Table 2 **Prevalence of srFA by demographic group: Comparison among 2001, 2006, and 2010 FSS**

Demographic Variables	Survey Year							
	2001 (N = 4482)		2006 (N = 4539)			2010 (N = 4568)		
	srFA, no. (%)*	95% CI	srFA, no. (%)*	95% CI	p Value#	srFA, no. (%)*	95% CI	p Value§
All	471 (9.0)	8.2–9.9	737 (14.9)	13.8–15.9	<0.001	574 (13)	12.1–14.0	<0.001
Sex								
Women	340 (11.4)	10.1–12.7	529 (18)	16.4–19.5	<0.001	422 (14.7)	10.0–12.6	0.001
Men	131 (6.5)	5.5–7.6	208 (11.4)	10.3–13.0	<0.001	152 (11.2)	10.0–12.6	<0.001
Age								
18–29 y	75 (8.1)	6.5–9.9	61 (12.6)	10.2–16.1	0.003	21 (17.3)	14.6–20.3	<0.001
30–39 y	81 (8.4)	6.7–10.4	113 (14.3)	11.3–16.4	0.001	59 (11.4)	9.5–13.6	0.034
40–49 y	118 (9.6)	7.8–11.7	141 (13.9)	11.6–16.2	0.007	87 (11.1)	9.0–13.5	0.344
50–59 y	82 (10)	7.9–12.2	193 (20.2)	17.5–22.6	<0.001	141 (15.7)	13.4–18.2	0.001
60–69 y	53 (7.7)	5.6–10.3	103 (13.6)	11.0–16.1	0.002	122 (11.7)	9.3–14.5	0.027
≥70 y	42 (8.7)	6.2–11.7	88 (12)	9.8–14.8	0.077	117 (10.6)	8.2–13.4	0.337
Race and/or ethnicity								
White	361 (8.9)	7.9–9.9	482 (13.1)	12.1–14.5	<0.001	429 (11.7)	10.6–12.8	<0.001
Black	40 (8.8)	6.9–11.9	70 (19.2)	16.0–22.8	<0.001	48 (23)	19.5–26.7	<0.001
Hispanic	35 (8.7)	6.4–11.5	105 (14)	10.4–16.0	0.026	55 (9.1)	7.1–11.6	0.788
Other	35 (11.6)	7.8–15.1	65 (28)	22.0–32.3	<0.001	56 (20.8)	16.2–26.1	0.002
Education								
High school or less	137 (6.6)	5.6–7.7	219 (12.5)	11.1–14.0	<0.001	166 (12.3)	10.9–13.8	<0.001
At least some college	329 (11.3)	10.0–12.6	505 (16.9)	15.4–18.4	<0.001	404 (13.8)	12.5–15.2	0.007

srFA = self reported food allergy; FSS = U.S. Food and Drug Administration Food Safety Surveys.
**Weighted percentages.*
#p value, comparing 2001 and 2006.
§p value, comparing 2001 and 2010.

fruits, and shellfish) as causes of allergic reactions in 2010 were unchanged from 2001.[19]

In 2010, the majority of adults in the srFA and ddFA groups reported experiencing skin symptoms (66.0% and 71.8%, respectively), followed closely by gastrointestinal symptoms in 64.2% and 65.7%, respectively; and respiratory symptoms were reported in 39.6% and 50.8% of respondents in both groups, respectively. Compared with 2001, there was a significant 18% increase ($p < 0.001$) in total gastrointestinal symptoms and a significant 20% decrease ($p < 0.001$) in reporting of total respiratory symptoms in individuals with srFA only. Specific only to the 2010 questionnaire, ~1 in 10 of those with ddFA (9.7%) reported having ever experienced anaphylactic shock in the past (Table 5).

For 2010 respondents with srFA and ddFA, 45% and 41.6%, respectively, reported experiencing an allergic reaction within the past 12 months; 26% and 24%, respectively, reported experiencing their last allergic reaction in the past 1 to 5 years, and 29% and 34%, respectively, reported having gone 5 years or more without an allergic reaction (Table 6). Compared with 2001, a statistically significant increase ($p < 0.001$) was noted in adults of either group reporting 5 years or more since their last allergic reaction. For 2010 respondents with ddFA, 8.4% had their most recent reaction treated with epinephrine. Also, 19.6% of these individuals reported going to see a physician for a reaction that occurred within the preceding 5 years and 15% reported having their allergic reaction treated in a hospital. Specific only to the 2010 questionnaire, 42% and 50% of srFA and ddFA, respectively, reported more than four allergic reactions to a food in the past 5 years.

With regard to food types and products that caused the allergic reaction in the past 5 years, the majority of reported reactions in 2010 were to prepared foods (44.6% srFA, 45.8% ddFA). If the reaction was from a prepared food, almost 60% of respondents in both FA groups indicated the food that caused their last allergic reaction was prepared in a retail environment (restau-

Table 3 **Prevalence of self-reported ddFA by demographic group: comparison among 2001, 2006, and 2010 FSS**

Demographic Variables	Survey Year							
	2001 (N = 4482)		2006 (N = 4539)			2010 (N = 4568)		
	ddFA, no. (%)*	95% CI	ddFA, no. (%)*	95% CI	p Value#	ddFA, no. (%)*	95% CI	p Value§
All	279 (5.3)	4.6–5.9	385 (7.6)	7.1–8.7	<0.001¶	323 (6.5)	5.4–6.8	0.092
Sex								
Women	224 (7.6)	6.6–8.7	293 (10)	9.0–11.5	0.002	255 (8.9)	7.3–9.5	0.354
Men	55 (2.7)	2.1–3.4	92 (4.9)	4.5–6.4	<0.001¶	68 (4)	3.0–4.6	0.059
Age								
18–29 y	37 (4.1)	3.1–5.6	26 (5.5)	3.9–8.1	0.189	10 (4.8)	3.4–6.7	0.532
30–39 y	52 (5.5)	4.1–7.1	54 (6.7)	4.9–8.6	0.323	29 (4.1)	3.0–5.5	0.194
40–49 y	70 (5.5)	4.1–7.1	78 (8.2)	6.3–10.0	0.037	49 (6.4)	4.8–8.3	0.441
50–59 y	50 (5.7)	4.2–7.5	103 (9.7)	8.3–12.2	0.001	78 (7.9)	6.3–9.8	0.076
60–69 y	35 (5.1)	3.5–7.3	56 (8.1)	6.0–10.0	0.062	74 (7.3)	5.4–9.6	0.144
≥70 y	27 (5.7)	3.8–8.3	54 (7.1)	5.9–10.0	0.201	72 (6.9)	5.0–9.3	0.444
Race and/or ethnicity								
White	212 (5.1)	4.4–5.9	257 (6.8)	6.2–8.0	0.002	238 (6.1)	5.3–9.4	0.1
Black	30 (6.5)	4.8–9.1	49 (13.2)	11.2–17.2	<0.001¶	32 (6.9)	5.0–9.4	0.876
Hispanic	18 (4.3)	2.7–6.3	49 (5.8)	4.3–8.3	0.187	28 (3.5)	2.3–5.2	0.548
Other	19 (6.3)	3.6–9.0	23 (9)	6.8–13.6	0.085	21 (11.5)	8.1–15.9	0.019
Education								
High school or less	86 (3.8)	3.1–4.7	118 (6.8)	6.0–8.2	<0.001¶	96 (5.0)	4.1–6.0	0.072
At least some college	192 (6.6)	5.7–7.7	262 (8.3)	7.6–9.9	0.009	224 (7.0)	6.1–8.1	0.622

ddFA = physician-diagnosed food allergy; FSS = U.S. Food and Drug Administration Food Safety Surveys.
**Weighted percentages.*
#p value, comparing 2001 and 2006.
§p value, comparing 2001 and 2010.
¶Differences were significant at $p < 0.001$; Bonferroni adjustment was applied.

rant, store, or bakery). The only significant change compared with 2001 was a 30% increase ($p < 0.001$) in reports of food types that were neither packaged nor prepared (*e.g.*, fruits) in the srFA group.

In 2010, the most common reported modality used for diagnosis was a skin and/or *in vitro* IgE test (53.7%) (Table 7). History or physical examination alone was reported in 20.9%, and "other" allergy test was reported in 19.2%. Oral food challenges were reportedly used in only 2.3% of the cases. Only 5.6% of adults reported a combination of history or physical examination and IgE-specific tests, criteria consistent with FA diagnosis in current clinical guidelines.[24] In regard to epinephrine prescriptions, we found that 15.3% of adults with ddFA reported being prescribed an epinephrine kit.

DISCUSSION

Because living with FA has nutritional, psychosocial, and other consequences that can negatively impact health and quality of life,[24–27] a proper diagnosis is essential. Analysis of sequential FSS found an increase in srFA without an associated increase in reported physician diagnosis in U.S. adults over a recent 10-year period. Analysis of our results indicates that a persistent and potentially increasing number of adults may be needlessly avoiding nutritious foods without seeking medical advice, which highlights a public health need for better education and communication to the public about seeking proper diagnosis as per established guidelines.[24]

Reasons for why adults are self-reporting an FA without obtaining a proper diagnosis are not completely understood and need to be examined further. Reporting of ddFA has been associated with higher, rather than lower, education as well as income level.[10,13,28] Thus, it is possible that education, with or without socioeconomic factors that may impact health care access, is likely contributing to this problem. Also, the 2010 survey finding that women significantly report more ddFA than men indicates a possible sex difference in reporting as well. Another observation

Table 4 **Number, weighted percentage, and population prevalence of persons with srFAs and ddFAs reporting allergy to a specific food by food category, 2010 Food Safety Survey**

FA	srFA			Self-Reported ddFA		
	No.	Percentage of Those with Allergic Reaction (n = 574)*	Prevalence (%) in the Total Sample (N = 4568)*	No.	Percentage of Those with Allergic Reaction (n = 323)*	Prevalence (%) in total sample (N = 4568)*
Any major food allergens#	436	75	9.8	255	76	4.6
Milk and/or dairy	177	31	4.1	96	32	2
Eggs	54	8	1	36	9	0.5
Fish	50	13	1.7	41	13	0.8
Shellfish	161	28	3.6	109	26	1.6
Tree nuts	52	10	1.3	33	12	0.7
Peanuts	46	6	0.9	28	10	0.6
Wheat and/or gluten	95	10	1.3	60	14	0.9
Soy	10	1	0.1	8	2	0.1
Other foods§						
Fruit and/or vegetable	148	21	2.7	88	27	1.6
Chocolate	11	1	0.1	7	1	0.1
Food additive	11	2	0.2	7	2	0.2

srFA = self reported food allergy; ddFA = physician-diagnosed food allergy; FSS = U.S. Food and Drug Administration Food Safety Surveys.

**Weighted percentages.*

#Major food allergen as defined by the Food Allergen Labeling and Consumer Protection Act[23]; persons might be allergic to more than one food.

§Percentage of persons with probable ddFA with allergic reactions to other foods: beans and/or legumes, 3.8%; spices, other seeds, 2% each; chocolate, 1%; other nuts, 1%; sesame, mustard seeds, <1%; other foods not specified, 11.2%.

from the 2010 survey results is the finding, only in the srFA group, of an increase in reporting of total gastrointestinal symptoms and a decrease in reporting of total respiratory symptoms in 2010 compared with 2001, which indicates that srFA may be increasingly represented by individuals with gastrointestinal predominant food concerns in whom diagnosis of FA is more difficult to ascertain.[24,29–31]

As per the 2010 survey, three of four adults with an srFA report reactions to at least one U.S. major food allergen. Fruits represent the largest reported food group outside of these major allergens to cause problems; consistent with high prevalences of fruit allergies seen in other adult populations, mostly in Europe.[32,33] There was no specific food found to be specifically overrepresented in adults who reported srFA compared with ddFA. The two most common individual major food allergens in 2010, milk and shellfish, are those consistently found to be the most common allergens in adults from other recent national surveys.[14,18]

Reaction severity characteristics in 2010 revealed that 15% of reactions required a hospital visit and that 8.4% were treated with epinephrine. Despite reporting of hospital visits being slightly increased, these frequencies were not different from 2001. However, although the percentage of adults who reported ddFA (42%) who last experienced an allergic reaction in the past 12 months had not changed significantly, 34% of respondents had gone ≥5 years since experiencing a reaction. This time delay in reaction frequency represented a significant increase ($p < 0.001$) since 2001, which indicated a possible shift toward improved prevention of reactions in some adult consumers. Evidence for such a shift over a similar time period as our study is supported by the finding of a decrease in frequency of adults who presented to U.S. emergency departments

Table 5 **Weighted percentage of reported reactions to foods for persons with srFAs and probable ddFAs, 2001 and 2010 FSS**

Symptom*	srFA (n = 574)		Self-reported ddFA (n = 323)	
	No. (weighted %)	% Increase from 2001 Study	No. (weighted %)	% Increase from 2001 Study
Skin	361 (66)	3	234 (71.8)	−4
Hives, itching, redness	281 (53.1)	9	194 (61.2)	1
Itchy throat, lips, or mouth	239 (43.1)	13	163 (48.3)	11
Swelling of face	169 (36.5)	3	127 (38.2)	−16
Respiratory	260 (39.6)	−20¶	179 (50.8)	−15
Throat tightness	190 (35.3)	−12	133 (39.9)	−17
Wheezing	153 (26.5)	−6	114 (34.1)	−3
Trouble breathing, shortness of breath, coughing	183 (29.2)	−14	−14 (36)	−15
Nasal congestion	164 (27.6)	−13	112 (35)	−14
Gastrointestinal	360 (64.2)	18¶	209 (65.7)	17
Stomach pain	313 (47.1)	10	185 (58.9)	34
Vomiting or nausea	190 (39.3)	42	121 (41)	45
Diarrhea	234 (35.4)	2	140 (43.9)	19
Other§				
Headache	161 (24.2)		106 (40)	
Dizzy	98 (15.3)		73 (23)	
Anaphylactic shock	37 (5.5)		31 (9.7)	

srFA = self reported food allergy; ddFA = physician-diagnosed food allergy; FSS = U.S. Food and Drug Administration Food Safety Surveys.

**Respondents could select more than one symptom.*

§Respondents were not asked about headache, dizziness, or anaphylactic shock in 2001.

¶Differences between 2001 and 2010 were significant at $p < 0.001$; Bonferroni adjustment was applied.

from 2001 to 2009.[34] However, because the number of reactions in the past 5 years was not assessed in the survey, it is impossible for us to assess the magnitude of this potential preventative effect in regard to reduction of overall reactions. Moreover, our findings of the timing of reactions may be skewed by recruitment of comparatively older adults in the 2010 compared with younger adults.

A limitation of our study and most other North American FA prevalence studies to date was that criteria for defining FA groups were not based on clinical-guideline validated diagnostic methods but primarily from self-reported cases. Self-reported data have traditionally been subject to reporter bias and overestimation of the true prevalence of clinical FA.[35] These data also do not discern whether the reported FAs were IgE mediated or due to other FA disorders, such as celiac disease or eosinophilic gastrointestinal diseases.[24] Although our study uses physician diagnosis report to identify more probable FA cases within the srFA group, the accuracy of self-report of physician-diagnosis data in estimating the true prevalence of clinical FA is unknown and may also be biased to overestimation. Indeed, our estimated prevalence of ddFA (6.5%) is substantially higher compared with prevalences in adults of ~2–3% determined based on clinically validated methods.[24,36–38] It is also noteworthy that food challenge, the criterion standard diagnostic method,[24] was reportedly used in only 2.3% of ddFA cases in adults, which was unchanged since 2001. This is a considerably low use percentage and, when compared with 20% of children reported to have food challenge in a recent national survey in children,[39] indicates a possible age-related discrepancy in use of this diagnostic method that needs to be investigated further.

Attention also is needed when comparing our study prevalence estimates with those from other national surveys due to differences in survey methodologies and criteria used for determining FA. Although our 2010 srFA prevalence estimate for adults is consistent with the 13% rate reported by national guidelines[24] and by systematic reviews of FA prevalence studies,[32,37] this estimate is higher than estimates of 8.6 to 10% from Canada[18] and the U.S.-based National Health and Nutrition Examination Survey data[14] taken over a similar time period. A likely explanation for this difference is that the FSS asked: "do you currently have any food allergy or suspect that you have a food al-

Table 6 **Severity characteristics of the frequency, treatment, and food product types (and place or location) associated with reported reactions, 2001 and 2010 FSS**

Variables	srFA (total n = 574)*		Probable ddFA (n = 323)*	
	No. (weighted %)	% Increase from 2001	No. (weighted %)	% Increase from 2001
Experienced last allergic reaction				
In the past 12 mo	246 (44.8)	−14	133 (41.6)	−13
In the past 1–5 y	116 (25.7)	−14	68 (24)	−27
>5 y	171 (28.6)	75¶	103 (33.4)	80¶
Never	9 (0.8)	56	4 (1)	100
No. reactions in the past 5 y§				
1	48 (24.5)		26 (13.9)	
2–4	87 (33)		50 (36)	
>4	157 (42.4)		87 (50.1)	
Treatment (reaction in the past 5 y)#				
Treated with epinephrine?				
Yes	24 (5.9)	−5	18 (8.4)	−17
No	332 (94.1)	0	177 (91.6)	2
Do not know/refused	6			
Where treated?				
Physician's office only	36 (9.5)	−44	31 (19.6)	−21
Hospital (including physician visit)	36 (7.2)	−4	33 (15)	25
Neither	290 (83.4)	10	137 (65.4)	3
Food type (reaction in past 5 y)				
Packaged food, no preparation	88 (33.5)	34	44 (30.9)	31
Prepared-packaged food from mix‖	28 (8)		13 (7.7)	
Prepared food‖	145 (44.6)		90 (45.8)	
Neither packaged nor prepared food (*e.g.*, fruit)	49 (13.9)	30#	27 (15.6)	30
If packaged food				
Simple: one or few ingredients (*e.g.*, milk, peanut butter)	50 (50.8)	−6	12 (43.7)	16
Complex: a lot of ingredients (*e.g.*, cookies)	55 (49.2)	7	37 (56.3)	10
If prepared food, where prepared				
Home	46 (22)	22	27 (24.7)	73
Others' home	20 (21)	163	11 (16.2)	71
Restaurant, store, bakery	106 (57)	−23	65 (59.2)	−22

srFA = self reported food allergy; ddFA = physician-diagnosed food allergy; FSS = U.S. Food and Drug Administration Food Safety Surveys.

**"Do not know" and "refused" are not included in the table; valid percentages are shown.*

¶α for statistical significance was <0.001; Bonferroni adjustment was applied.

§Number of reactions in the past 5 y was not asked in 2001.

#These survey questions in 2010 were limited to those who experienced allergic reactions in the past 5 y; comparisons with 2001 data were made only for those with reactions in the past 5 y.

‖The 2001 question about food type did not include an option for "packaged food, needs preparation," nor did it specify "nonpackaged prepared foods"; therefore, no between-year comparisons could be made.

lergy?" whereas the Canadian survey and U.S. National Health and Nutrition Examination Survey asked: "Do you have any food allergies?" This subtle difference of asking about suspected cases likely contributed to higher estimates of srFA, and these higher estimates may also have contributed to reported differences observed between srFA and ddFA in our study compared with other studies.[18,39] Differences in

Table 7 **Reported method of physician diagnoses for those with reported ddFA: Modality and use (alone or combination), 2010 FSS**

2010 (Total $N = 323$)					
Diagnosis Method Modality			**Diagnosis Method Alone or Combination**		
	n*	**% of total *N*#**		***n***	**% of total *N*#**
History or physical examination	78	20.9	History or physical examination only	48	13.4
Skin or *in vitro* IgE test	165	53.7	History or physical examination and skin or *in vitro* IgE test	19	5.6
"Other" allergy test§	73	19.2	Skin or *in vitro* IgE Test only	135	42.5
Food elimination	25	7.3	History or physical examination and "other" allergy test§	24	6.9
Oral food challenge	6	2.3	"Other" allergy test only§	23	4.4
Do not know	35	14.1			
Prescribed epinephrine	62	15.3			

ddFA = physician-diagnosed food allergy; FSS = U.S. Food and Drug Administration Food Safety Surveys.
**Respondents could indicate more than one diagnosis method modality.*
#Weighted percentages.
§Includes vague responses, such as "allergy shots," "allergy test," "passed out," and "computer."

how the survey questions are asked can lead to wide discrepancies in srFA rates. Indeed, a meta-analysis of published FA prevalence studies found the overall prevalence of FAs in the population to vary greatly, from 1–2% to 10%, differences largely due to varying study designs and diagnostic criteria used (*e.g.*, self-report, food challenge confirmation).[40]

In regard to comparisons between survey years, this study had an important limitation to highlight. A notable difference in survey response rates was observed between the 2001 (36%) and 2010 (14%) surveys. Response rates are often considered an indicator of data quality, and low response rates are seen as a potential, but not necessarily definite, source of nonresponse bias.[41] To assess whether the 2010 FSS has nonresponse bias, we conducted a nonresponse bias analysis and found that respondents were not different from nonrespondents on demographics and other key survey variables. Also, because the main and stated purpose of the survey was to assess food safety knowledge, attitude, and behavior, we would not expect a selection bias toward individuals with FAs compared with those without allergies, which is a problem that requires adjustment with some FA prevalence surveys (see, *e.g.*, Soller[18]).

The decline in response rates between survey years has been observed with other digit-dial survey studies[7] and is likely due to the overall decline in telephone survey response rates and the increase in cell phone–only households.[42] Overall, there were far fewer respondents in the 18–29-year-old and 30–39-year-old age groups in 2010 compared with 2001. There was also an increase in the number of individuals ages ≥70 years in 2010. The differences can mainly be explained by the increase in the proportion of older adults in the U.S. population in 2010 compared with 2001, the rise in the use of cell phones over the same time period, and the high percentage of young adult cell phone usage.[43]

Despite the above limitation, our finding that srFA prevalences significantly increased in both 2006 and 2010 surveys and were consistently found in certain demographic groups strongly supported a conclusion that srFA (without concomitant ddFA) has increased in the U.S. adult population.

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